Notes on the Flora of Caroline Atoll

by

C. R. Long

Caroline Atoll situated between 150 14' and 150 13 west longitude and 9 55' and 10 55' south latitude is composed of three large islands. Two of these, Nake Island and Long Island are separated by a mud flat at low tide. Togather these two islands form a land mass approximately 2.2 miles long at the north end of the atoll. South Island is about 1 mile wide and .35 miles long at the widest point. In between these islands which form the north and south extremities of the atoll are numerous small islets ranging from a few acres to less than a half acre in extent. The largest of these Arundel, Brothers and Pig Islands lie on the windward side of the atoll. Many of the smallest islets are found on the leeward side. The atoll is approximately 5.35 miles long with the land mass lying at an angle to the northeast as far as the southern extremities of Long Island and curving toward west of north along the length of Long Island and Nake Island.

Vascular plants were collected on June 17 and 18, 1965 under the auspices of the Pacific Ocean Biological Survey Program, Division of Birds, Smithsonian Institution. Herbarium sheets are deposited in the herbarium of the University of Hawaii with duplicates, where available, in the herbaria of the United States National Museum and the Bishop Museum. Vascular plants were recorded (collection and whereabouts uncertain) by Bennett (Bennett, 1840) and later a number of specimens were collected by Dixon (see Trealease, 1884). The latter collection has been examined with the cooperation of Dr. Hugh H. Iltis , Curator of the herbarium of the University of Wisconsin. Collection numbers are those of my serial sequence.

PSILOPSIDA

Psilotaceae

Psilotum nudum (L.) Beauv.

Nake Is., common on wet base of Cocos, No. 3233. Dixon whose collections were from the South Island alone did not collect or record this species. The author was unable to find Psilotum on any other island or islet on the atoll. Nake Island judging by the frequency of Psilotum and Tacca had received more precipitation before the visit of the Pacific Program party than the other portions of the atoll. The more robust mesic Cocos groves also support this observation.

FILICES

Polypodiaceae

Microsorium scolopendrium (Burm. f.) Merr.

Reported by Dixon (as Polypodium phymatodes L.); Nake Is., groundcover under Cocos forests, No. 3244; Long Is., north end, under scattered Cocos, No. 3250; South Is., No. 3287. This widespread Pacific fern appears to be thriving even under very dry conditions.

SPERMATOPHYTA

Pandanaceae

Pandanus tectorius Park.

Tree 2.5 meters high, at edge of second islet south of Nake Is. (west side), No. 3227. Also observed on Nake Island (see Fig. 1.). — don't have

Gramineae

Lepturus repens (Forst. f.) R. Br.

Tufts to 1.5 decimeters high, in coral sand, second islet south of Long Island, No. 3211; islet northeast of South Island, No. 3221; growing in coral sand several meters above lagoon, common, Nake Island, No. 3236; on east windward side of Nake Island, exposed site, in sand, No. 3238; exposed site, in sand, Long Island, No. 3247; near lagoon shore, fourth islet north of Bird Island, west side, No. 3259; numerous clumps

under Suriana, South Island, No. 3286. Collected by Dixon (as L. repens R. Br.).

Palmae

Cocos nucifera L.

Dry groves, South Island, No. 3285. Extensive stands cover Nake and South Islands with a scattered number on the north portion of Long Island. The Cocos was probably present on Caroline Atoll at the time of the European discovery in 1795 (see Bryan, 1942). Commercial extension of the pre-existing groves was carried out by John T. Arundel who also mined guano from the atoll.

Taccaceae

Tacca leontopetaloides (L.) O. Ktze.

Occasional in moist sites (muck), South Island, No. 3212; in fruit, South Island, No. 3219; common under Cocos forests, Nake Island, No. 3234. Numerous patches were found in muck on the south end of Nake Island. A new record for the atoll.

Urticaceae

Fleurya ruderalis (Forst. f.) Gaud. ex Wedd.

Common in shady areas, South Island, No. 3215; scattered in coral rubble and sand, exposed site, second islet south of Nake Island (west side), No. 3229; under shade of Cocos and Pisonia, Long Island (north side), No. 3253. Many seedlings were observed on Long Island. Collected by Dixon.

Nyctaginaceae

Boerhavia repens L.

Light purple flowers, second islet south of Long Island, No. 3210; stems to .6 meters long, large coriaceous leaves, red stems, islet northeast of South Island, No. 3224; Nake Island, No. 3239; stems to .5 meters long, rooting at nodes, Nake Island, No. 3225; Long Island, north end, No. 3252; fourth islet north of Bird Island, No. 3262; in shade, South

Island, No. 3289, 3291. Reported by Bennett as B. hirsuta. Collected by Dixon.

Pisonia grandis R. Br.

Tree about 4 meters high, north shore, South Island, No. 3280. A small grove was observed on the north end of Long Island. This species forms a forest association on many central Pacific atolls where the aboriginal vegetation survives. The clearing necessary for guano mining and the planting of Cocos plantations may have destroyed any former extensive Pisonia forests on Caroline Atoll. The presence of commercial quantities of guano also points to a pre-existing stand of Pisonia if the laying down of such deposits is indeed accomplished under Pisonia stands (Fosberg, 1957). Collected by Dixon.

Portulacaceae

Portulaca lutea Sol.

Stems clumped, flowers yellow, islet northeast of South Island, No. 3223; clumps 1.5 decimeters high, common, in open coral sand and rubble, second islet south of Nake Island, No. 3231; common, Nake Island, No. 3237; in gravel above lagoonshore, common, Long Island (north end), No. 3255; fourth islet north of Bird Island, No. 3257; common in exposed area, South Island, No. 3292. Collected by Dixon. A second species, probably P. oleracea, was recognized by Dixon. This species Was not seen in 1965. For P. lutea see Fig. 2. — Don't have

Zygophyllaceae

Tribulus cistoides L.

In open area, sand, among Tournefortia shrubs, stems to .8 meters long, Long Island, No. 3245. This species is probably distributed by sea birds but was not seen elsewhere on the atoll. A new recoed for the atoll.

Simaroubaceae

Suriana maritima L.

CS east side of long. Is.

Shrub to 1.8 meters near edge of islet, east side, islet northeast of South Island, No. 3220; shrub 1.5 meters high along lagoon shore, edge of water, South Island, No. 3279. Collected by Dixon. See Figs. 3 and 4.

CS north side of South Is on leeg

Euphorbiaceae

Phyllanthus amarus Schum. and Thonn.

Herb to 4 decimeters, common on the north side of South Island, No. 3283. Collected by Dixon as P. niruri L.

Convolvulaceae

Ipomoea pes-caprae ssp. brasiliensis (L.) Van Ooststr.

Stems to 7 meters long, in fruit, near copra shed, north shore, South Island, No. 3281. Only one plant seen on the atoll. A new record for Caroline Atoll.

Ipomoea tuba (Schlecht.) Don

Trailing vine, white flowers, common, stems to 6 meters long, South Island, No. 3228; Nake Island, No. 3242; trailing on Tournefortia, Long Island, north end, No. 3251; climbing over Morinda and Cocos, stems to 25 meters, South Island, No. 3293.

Boraginaceae

Cordia subcordata Lam.

Tree to 4 meters, near lagoon, South Island, No. 3213; tree to 3 meters high on interior of islet, in coral rubble, about 15 meters above high tide line, second islet south of Nake Island (west side), No. 3228; tree to 4.5 meters high, orange flowers, common on interior of islet, Long Island, north end, No. 3246; fourth islet north of Bird Islet, No. 3261; tree to 4 meters, at edge of water, north shore along lagoon, South Island, No. 3261. Collected by Dixon. See Fig. 5. CS-grove of Cordia trees Nong Is.

Heliotropium anomalum H. and A.

In gravel of outer beach, islet northeast of South Island, No. 3222; clumps to 1.2 decimeters high, in exposed

site, rooted in coral gravel, common on the lagoon side of the islet, second islet south of Nake Island, west side, No. 3230; in sand, edge of lagoon, Nake Island, No. 3240; gravel of lagoon shore, Long Island, No. 3248; fourth islet north of Bird Islet, No. 3256; clumps to 2.8 decimeters high, coral gravel under Suriana, southwest side of South Island, No. 3288. Reported by Dixon.

Tournefortia argentea L. f.

Small tree, 2.5 meters high, white flowers, edge of lagoon, South Island, No. 3216; edge of islet, islet northeast of South Island, No. 3226; shrub 3 meters high, edge of islet above high tide line, Nake Island, No. 3241; Long Island, No. 3249; common, fourth islet north of Bird Islet, No. 3258.

Rubiaceae

Small tree, 2 meters high, South Island, No. 3214; young plant, 6 decimeters high, South Island, No. 3217; shrub to 2.5 meters, Nake Island, No. 3232; common at edge of Pisonia forest, north end of Long Island, No. 3254; small tree to 3 meters forming dense thickets, central area of South Island, No. 3282.

Dixon also collected the following: Lepidium piscidium Forst. = L. bidentatum Mont.; Calophyllum inophyllum L.; Russelia juncea Zucc. = R. equisitiformis Schlecht.; Boussingaultia basseloides H. B. K. = B. gracilis Miers forma pseudobasseloides Hauman; Ficus carica L.; Eleusine indica Gaertn.; Eragrostis plumosa LK. = E. tenella (Link) Beauv.; Sida fallax Walp. None of these species were seen in 1965. Also reported by Dixon were: Carica papaya L.; Curcubita pepo L.; Ananas sativa L.; Cocos nucifera L. and Panicum margurata LK. which appears to be a Digitaria sp. This latter may be identical to No. 3235 of my numbers. A number of the species above were apparently introduced in the latter half of the last century as ornamentals and food plants. None of the above with

the exception of the Cocos and Digitaria could be found. The general aspect of the vegetation indicated a lengthy dry spell prior to our visit.

The Vegetation of Caroline Atoll

The earliest recorded observation of the vegetation of Caroline Atoll is found in Bennett (Bennett, 1840). In this volume the author related that Cocos were found on the South Island only (see map page 366) - a grove on the northeast side of South Island. The area covered by this grove is approximately one-fifth of the land area of South Island. Bennett refers to the island as "covered with verdure" and goes on to say that " the interior of the island is a surface of sand, mingled with coral debris as well as with decayed vegetable and animal matters, which give it increasing fertility". He also mentions trees "attaining the height of twenty feet". This may indicate that the Cordia and or Pisonia groves covered a more extensive area in the last century. Bennett mentions that " the woodlands are chiefly composed of two species of Tournefortia". It is difficult to interpret this statement other than by supposing Bennett was referring to Cordia as well as Tournefortia. Three species were introduced by Bennett: Ipomoea batatas, Tacca leontopetaloides and Inocarpus edulis Forst. No sign of any of these species other than the Tacca was found in 1965. The early observation of only this smallish grove of trees on South Island bears witness to an early aboriginal population or visiting population of Polynesians who planted groves extensive enough to cover the needs of the people. Later under the auspices of Brown and Bros. (Salmon in Holden, Mem. Nat. Acad. Sci. 2: 2-22) more Cocos were planted on the island and, presumably on Nake Island. In 1872 guano operations were begun (Arundel in Holden, Mem. Nat. Acad. Sci. 2: 2-22). It is not clear whether the guano was mined on South Island or Nake Island or both from these early reports. However since the settlement was on South Island it would be plausible to assume that at least some of the mining was

carried out on South Island.

Below is a short summary of the vegetation of each large island and the other islet groups as observed in 1965.

South Island. Old Cocos groves cover the greater portion of South Island. Interspersed in these old groves are thickets of Morinda often associated with Ipomoea tuba. In some open areas where Cocos trees have died or been felled by natural causes the grass Lepturus repens forms a nearly closed stand with Ipomoea. A Suriana - Lepturus zone forms a fringing association around South Island. On the north side bordering the lagoon the Suriana forms a dense continuous shrub border (see Fig. 4.). On the west, south and east sides the Suriana shrubs are taller, less compact and more scattered (see Fig. 3.). Patches of Lepturus are scattered about often extending well outside and beyond the Suriana zone toward the high tide line.

Nake Island. Like South Island Nake has been planted to Cocos. The groves extend the entire length of the island. (See Fig. 7 and Fig. 8.). In open patches of the interior and along the edge of the Cocos stands occur associations of Pandanus, Morinda and Tournefortia. Along the northeast side an almost continuous riming stand of Tournefortia lines the area between the groves of Cocos and the open sandy beach with scattered clumps of Lepturus and the ubiquitous Boerhavia repens. Some of the older Tournefortia trees may reach almost 3 meters high. In damp muck areas under the Cocos groves Tacca is found in scattered groups.

Long Island. On the north end of Long Island are clumps of Morinda and Cordia. As one walks south along the lagoon edge of the island Pisonia trees are observed with Cordia and Morinda. (See Fig. 6.). On both sides of the island Tournefortia forms a fring with open areas supporting Lepturus in scattered bunches. On the south end of the island occurs an open area among Tournefortia shrubs. Here in open sand was found the only Tribulus to be found on the entire atoll. On the north side lesser frigate-

birds were observed nesting in the Morinda trees while the south half of the island with a predominant cover of Tournefortia was supporting a high population of sooty terns which were nesting in open areas as well as under the rather dense Tournefortia vegetation. No Scaevola taccada was observed on the atoll. The niche usually occupied by this species appears to be occupied solely by Tournefortia.

Windward Islets. A small Cordia grove appears on most of these small islets on the east side of the atoll. Brothers Islet has a few Cocos trees. Suriana which is not found on the islets and larger islands on the north side of the atoll is found to 3 meters high on the islet between South Island and Arundel Islet. This seems to form a very dense stand with Tournefortia. Tournefortia is also an important component on the other windward islets.

Leeward Islets. The vegetation of these islands is much more sparse than those of the windward side of the atoll. Pandanus occurs on the three small islets south of Nake Island. Further south lies an islet with a few Cocos trees and Pisonia. The other islets to the south have Cordia and Tournefortia with Lepturus, Fleurya and Heliotropium. The Fleurya occupies small sand filled nitches in the coral rubble often fully exposed to the elements while the Heliotropium is found in sand on the lagoon side of the islets.

Scattered individuals of Pisonia grandis now occur on South Island and Long Island. An occasional tree appears elsewhere but never forming a dense stand. These may represent remenant stands of this common species which may play an important role in the laying down of a phosphatic hardpan on atolls (Fosberg, 1957). This phenomenon was observed on Vostok and Washington Islands and on Palmyra Atoll where a phosphatic hardpan invariably occurs under dense stands of Pisonia. This seems the probable source of the guano mining carried out on many of the central Pacific Islands and appears also to explain the initial flourishing condition of

Cocos plantations laid out in areas formerly covered by native vegetation. Many of the aspects of atoll vegetation and morphology pointed out by other authors (Fosberg, 1953) are prominent in the vegetation of Caroline Atoll.

Literature Cited

Bennett, F. D. 1840.
Narrative of a whaling voyage round the globe from the year 1833 to 1836. London.

Bryan, E. H., Jr. 1942.
American Polynesia and the Hawaiian Chain. Honolulu.

Fosberg, F. R. 1953.
Vegetation of Central Pacific Atolls, a Brief Summary. Atoll Research Bulletin 23: 1-25.

Fosberg, F. R. 1957.
Some Geological Processes at Work on Coral Atolls. Trans. N. Y. Acad. Sci. 2: 411-422.

Treelease, W. 1884.
Plants collected in Caroline Island by Mr. Dixon. Mem. Nat. Acad. Sci. 2:88-90.

Fig. 1. Pandanus tectorius and Tournefortia argentea, southeast end of Nake Island. This association occurs at the edge of Cocos forests and in open areas with Morinda.

Fig. 2. Portulaca lutea Sol. in raised mud flats near northwest shore of Long Island. This species commonly is a pioneer on areas which are elevated above the high tide line on the mud flats. Areas toward the sandy shore are populated with Lepturus and Boerhavia.

Fig. 3. East side of Long Island with Tournefortia fringe vegetation and scattered Suriana shrubs. Lepturus repens forming patches in the foreground. Cocos to the left.

Fig. 4. North side of South Island on lagoon. A fringing vegetation of thick Suriana shrubs is found at the high water line. An occasional Pisonia or Cordia tree is found between the Suriana fringe and the Cocos forest.

Fig. 5. Grove of *Cordia* trees with *Tournefortia* in the in the foreground. Long Island supports several dense groves of *Cordia subcordata* under which a thin leaf layer and several inches of dark humus were found.

Fig. 6. The north portion of Long Island as seen from the south point of Nake Island. In the middle of the land mass are groves of *Cordia* and *Pisonia* with a dense fringing cover of *Tournefortia argentea*.

Fig. 7. The north end of Long Island with *Cocos* forests and *Tournefortia* shrubs. The bare mud flats are covered during the high tides and separate Nake from Long Island.

Fig. 8. Upper end of Long Island. The areas in the foreground have some dry land above the highest tide waters. These areas support pioneer associations of *Lepturus*, *Boerhavia* and *Portulaca*.